CHEMICAL HAZARD SUMMARY

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Acetone

(CAS 67-64-1) (CH_3 $COCH_3$)

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SCOPE OF THE DOCUMENT

This document focuses on the hazards of acetone. The toxicity, fire and explosion hazards and reactivity of acetone are described. Information relevant to the workplace is emphasized. Special attention is given to the main hazard presented by acetone. Information on protective measures, storage, handling, clean-up and disposal, and first aid is also included in this document.

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I. MAIN HAZARD

The main hazard of acetone is its extreme flammability.

II. OCCUPATIONAL EXPOSURE

Acetone is a clear, colourless liquid. Its vapour has a sweet odour.

Acetone is commonly used as a solvent in various products:

- fats, waxes and oils
- paints, varnishes and lacquers
- resins and plastics
- cellulose derivatives
- thinners
- paint, varnish and lacquer removers
- sealants, adhesives and rubber cements

It is also used in the manufacture of various materials:

- rayon, synthetic leather and silk
- explosives and smokeless powders such as cordite
- other chemicals, such as methyl methacryalate, chloroform and diacetone alcohol
- photographic film
- vitamins and other pharmaceuticals

Acetone is also used to clean precision parts, such as those used in watches and electronic equipment.

The most common routes of exposure to acetone in the workplace are inhalation of the vapour and direct contact of the liquid with the skin or eyes. Liquid acetone can be absorbed slowly in small amounts through unbroken skin. It can also be ingested (swallowed). However, absorption through the skin and ingestion of acetone are usually not important routes of exposure in the workplace.

General information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body"[1].

III. HEALTH HAZARDS

Removal from the Body

If a small amount of acetone is absorbed into the body, most of it is broken down to carbon dioxide. The rest is breathed out by the lungs or passed out of the body, unchanged, in the urine.

If a large amount of acetone is absorbed into the body, most of it is exhaled or passed out, unchanged, in the urine. A smaller amount is broken down to carbon dioxide.

Effects of Short-Term Overexposure in Humans

Inhalation

There is a risk that acetone may be inhaled in large quantities, since it evaporates easily. However, poisoning by inhalation of acetone is rare because acetone is not very harmful.

Acetone vapour irritates the nose and throat at air concentrations of about 500 to 1000 parts per million (ppm). The irritation is usually considered to be slight at 500 ppm, but quite noticeable as concentrations approach 1000 ppm[2,3,4]. There have been reports of headaches and light-headedness at 1000 ppm[3].

Inhalation of concentrations higher than 2000 ppm causes dizziness, a feeling of drunkenness, drowsiness, nausea, and vomiting. Unconsciousness may result if exposure is extremely high (concentrations are greater than 10 000 ppm).

One report[5] shows that, even at extremely high concentrations, acetone vapours do not cause irreversible health effects. The report describes the experience of two men working in an area contaminated with acetone vapour. Acetone levels were found to be greater than 12 000 ppm when measurements were taken 3 hours, 18 hours and 1 week after the incident. The two men worked in the contaminated area for 4 hours and noticed irritation of the eyes and throat, headache, weakness in the legs and a feeling of drunkenness. The men then left the area for 1 hour. On their return, one man collapsed and the other felt faint. Rescuers, who were exposed for 2 to 3 minutes, experienced irritation of the eyes and throat, headache, dizziness, light-headedness and weakness in the legs. The man who had lost consciousness regained consciousness a short time later but was confused, drowsy, unsteady on his feet, and felt nauseated and was vomiting. The other man had, at this point, lost consciousness and was vomiting. There were no after-effects reported for any of the exposed men.

There have been two reports[6,7] of possible kidney and liver damage caused by inhalation of acetone vapour. The concentration of vapour inhaled was not given in either case, but it is probable that the exposures were extremely high.

Eyes

Acetone vapour causes mild irritation to the eyes at air concentrations of around 500 ppm[2,4]. Irritation is very noticeable at 1000 ppm[3].

Liquid acetone is moderately irritating if it is splashed into the eyes. Complete healing usually occurs within a day or two. In one unusual case[8], liquid acetone was held directly on the eye for a prolonged period of time. In this particular case, there was permanent damage to the eye, with clouding of the cornea.

Skin

Liquid acetone can cause mild irritation if it comes into contact with the skin. Acetone vapour may slightly irritate the skin if the air concentration is extremely high.

There are several reports[9] of non-occupationally exposed people becoming ill from acetone apparently absorbed through unbroken skin. The symptoms described are similar to those which occur when large amounts of acetone vapour are inhaled. All of the cases involved people who were having lightweight casts put on to mend broken limbs. Most of the persons affected were young children who may be more sensitive to the effects of acetone. In all of the cases, a large amount of acetone came into contact with the skin for several hours while the cast was setting. It is not known how much of the exposure was due to skin absorption, since some acetone vapour was also inhaled. These reports have little relevance for people exposed at work, because it is extremely unlikely that workers would come in contact with such a large amount of acetone for such a long time.

Ingestion
It is unlikely that ingestion or swallowing of acetone would occur in the workplace.

One report[10] describes the effects of acetone on a man who intentionally drank 200 mL (about 7 ounces). Within one hour, he had flushed cheeks and appeared drunk. His breathing was shallow; his throat was red and swollen. He soon lapsed into a coma and did not regain consciousness for 12 hours. Four weeks later, he noticed an increase in thirst and frequency of urination. His doctors discovered an increase in his blood sugar levels. These symptoms are similar to those caused by diabetes. It is not known if this person continued to experience these effects or if he fully recovered.

Effects of Long-Term Overexposure in Humans

Carcinogenicity
There is no evidence that exposure to acetone causes cancer.

Effects on Body Tissues and Organs
There are few reports of adverse health effects caused by long-term exposure to acetone, despite its extensive use as an industrial solvent.

Long-term contact with liquid acetone removes natural oils from the skin. Symptoms such as dryness, irritation, redness and cracking of the skin can result.

One German report[11] describes the effects on workers exposed to acetone vapour concentrations of 700 ppm and 1000 ppm for 3 hours a day for 7 to 15 years. Symptoms included irritation of the airways, throat, stomach and the small intestine and, occasionally, dizziness, attacks of giddiness and a loss of strength. There are no other reports of illness due to long-term exposure to acetone.

Toxicity Data in Animals and Laboratory Tests

Lethal Dose Values
The poisoning strength of a compound can be estimated from the LD_{50} obtained

in animal tests. LD stands for lethal dose. The LD_{50} is the amount of a chemical (weight of chemical per weight of animal) which is needed to kill one-half (50 percent) of the test animals. Test animals are usually rats, mice or other rodents. Routes of exposure are usually by mouth (oral) or through the skin (dermal). The values obtained for acetone by different researchers are:

LD_{50} (rat, oral)	5800 mg/kg[12]
LD_{50} (rat, oral)	9750 mg/kg[13]
LD_{50} (mouse, oral)	3000 mg/kg[12]
LD_{50} (rabbit, dermal)	20 000 mg/kg[12]

Further general information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[14]

Other Animal Data
In one animal study[15], guinea pigs were exposed to many small doses of acetone over a period of 3 to 8 weeks. The acetone was either applied directly on the skin or under the skin. Many of the guinea pigs developed cataracts. In some cases, the eye damage was considered to be reversible. In a repeat study, cataracts developed in guinea pigs but not rabbits. It is questionable how relevant this type of study is to people who are exposed to acetone at work. There is no evidence that skin contact with acetone causes cataracts in humans.

In laboratory animals, acetone has been shown to increase harmful effects on the liver caused by several other organic chemicals[16]. Examples of these chemicals are carbon tetrachloride; chloroform; 1,1,2-trichloroethane; trichloroethylene; bromodichloromethane and dibromochloromethane. To date, these effects have not been seen in humans.

IV. FIRE AND EXPLOSION HAZARDS

Acetone is highly flammable and can be a severe fire hazard. The vapour easily forms explosive mixtures with air at room temperature. Even water solutions of acetone can be very flammable if not highly diluted.

The fire or explosion hazard of a substance is normally described by the flash point and flammable or explosive limits.

The flash point of acetone is -20°C (-4°F). When acetone is at or above -20°C, enough vapour is produced near the surface of the liquid to form a flammable or explosive mixture of vapour and air. An ignition source will cause this mixture to burn or explode.

The flammable or explosive range of acetone in air is 2.5 to 13% (25 000 to 130 000 ppm). The lowest concentration of the material in air which can burn or explode is called the Lower Explosive Limit (LEL) or the Lower Flammable Limit (LFL). The LEL for acetone is about 2.5%. Similarly, the highest concentration of the material in air which can burn or explode is called the Upper Explosive Limit (UEL) or the Upper Flammable Limit (UFL). The UEL for acetone is 13%. Between the LEL and the UEL, hazards include the possibility of explosion in

confined spaces or the possibility of flashback: a fire travelling along the line of vapour or gas from a spark or flame to a container or spill. When the concentration is below the LEL, the air/chemical mixture is too "lean" to burn, and when the concentration is over the UEL, the mixture is too "rich." Adequate ventilation can prevent the accumulation of explosive concentrations of the airborne material in work or storage areas.

V. CHEMICAL REACTIVITY HAZARDS

Acetone will attack most common synthetic fibers, including nylon.

Acetone reacts violently with:

- oxidizing agents, such as peroxides, nitrates and perchlorates; and
- halogenated hydrocarbon/alkali mixtures, such as chloroform/sodium hydroxide and bromoform/potassium hydroxide mixtures.

Acetone also reacts vigorously with sulfur dichloride and hexachloromelamine.

VI. EXPOSURE LIMITS

Many Canadian jurisdictions have exposure limits similar to those established by the American Conference of Governmental Industrial Hygienists (ACGIH). The following exposure limits have been established by ACGIH for acetone:

A time-weighted average value of 750 parts per million (ppm) or 1780 milligrams per cubic metre (mg/m^3).

A short-term exposure limit of 1000 parts per million (ppm) or 2375 milligrams per cubic metre (mg/m^3).

Contact the appropriate authority in your jurisdiction for details of the specific regulations which apply. Refer to ACGIH documentation for information on their exposure limits.

VII. EXPOSURE CONTROL

In operations where acetone is used in small amounts at room temperature, general or dilution ventilation may be adequate to keep exposures under control. Explosion-proof local exhaust ventilation is normally needed with large-scale use or use at elevated temperatures.

Protective Clothing
Protective clothing (gloves, aprons, coveralls, boots) should be worn, as needed, to prevent skin exposure to the liquid.

Acetone will attack most common synthetic materials so many materials will not provide adequate protection. Clothing made from butyl rubber or styrene-butadiene rubber (SBR) provides good protection from acetone[17].

Splash-proof chemical safety goggles or a face shield (eight-inch minimum) should be worn if there is a risk of splashing liquid acetone into the eyes.

Eye-wash fountains and safety showers should be located in areas where there may be direct contact with acetone.

Respiratory Protection
Factors to be considered when implementing a respiratory protection program include:

- Selection of appropriate respirators
- Respirator fit testing
- Respirator maintenance
- Worker training
- Inspection
- Cleaning
- Program evaluation

These factors are described in more detail in the CSA Standard Z94.4 "Selection, Care, and Use of Respirators", available from the Canadian Standards Association.

The degree of respiratory protection required depends on the concentration of the vapour and the duration of exposure. NIOSH[18] recommends the following respiratory protection for acetone vapour concentrations*:

Up to 1000 ppm:
Any chemical cartridge respirator with organic vapour cartridge(s), or any powered air-purifying respirator with organic vapour cartridge(s), or any supplied-air respirator, or any self-contained breathing apparatus.

Up to 6250 ppm:
Any supplied-air respirator with a tight-fitting facepiece operated in a continuous flow mode**.

Up to 12 500 ppm:
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister, or any supplied-air respirator with a full facepiece, or any self-contained breathing apparatus with a full facepiece.

Up to 20 000 ppm:
Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode.

*: These recommendations apply only to equipment approved by NIOSH or MSHA.

**: Eye protection may be required.

Emergency or planned entry in unknown concentrations or IDLH conditions* :**
Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode, or any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode.

Escape from unknown concentrations:
Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister, or any appropriate escape-type self-contained breathing apparatus.

***: For the purpose of respirator selection, the "Immediately Dangerous to Life or Health" (IDLH) level represents the maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. The IDLH for acetone is 20 000 ppm.

VIII. SMALL-SCALE STORAGE AND HANDLING

Store acetone in suitable, labelled containers in a cool, dry, well-ventilated area, out of direct sunlight. Wherever possible, use fire-resistant containers. Keep acetone away from heat and ignition sources and away from incompatible materials. Store acetone in a fire-resistant, grounded cabinet. Use grounded, non-sparking ventilation systems and electrical equipment that does not provide a source of ignition. Keep containers tightly closed when not in use and when empty. Protect containers from damage. Have appropriate fire extinguishers available in or near storage area.

Do not allow lighted cigarettes, matches or any other ignition sources in or around storage or usage areas, indoor or outdoor. Wear appropriate protective equipment to avoid skin or eye contact.

IX. FIRST AID

The following general procedures are suggested for first aid involving overexposure to acetone:

Inhalation
Remove the source of acetone contamination, if this can be done safely, or move the victim to fresh air. If breathing has stopped, have properly trained personnel begin artificial respiration or cardiopulmonary resuscitation (CPR) immediately. Obtain medical attention immediately.

Skin
As quickly as possible, flush contaminated area with lukewarm, gently flowing water for at least 10 minutes. Under running water, remove contaminated

clothing, shoes and leather goods (e.g. watchbands, belts). If irritation persists, obtain medical advice.

Eyes
Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 10 minutes, holding the eyelid(s) open. Obtain medical attention immediately.

Ingestion
Never give anything by mouth if victim is rapidly losing consciousness or is unconscious or convulsing. Rinse mouth thoroughly with water. Do not induce vomiting. Have victim drink 8 to 10 ounces (240 to 300 mL) of water to dilute acetone in the stomach. Obtain medical attention immediately.

Note: Provide general supportive measures (comfort, warmth, rest). Consult a physician and/or the nearest Poison Control Centre for all exposures except minor instances of inhalation or skin contact. All first aid procedures should be reviewed periodically by a physician familiar with acetone and its use in the workplace.

X. FIRE FIGHTING

Dry chemical, "alcohol" foam or carbon dioxide may be used to extinguish a fire involving acetone. Water may be ineffective for putting out a fire, but should be used to keep fire-exposed containers cool. If a leak or spill has not ignited, water can be used to disperse acetone vapours. Water spray may also be used to flush spills away from areas where people are exposed, and to dilute spills to non-flammable mixtures.

XI. CLEAN-UP AND DISPOSAL

Restrict access to area. Provide adequate protective equipment to emergency response personnel and ensure the area is well-ventilated. Remove sources of heat or flame.

Stop or reduce acetone discharge if it can be done safely. Contain spilled material. Recover spilled acetone, if possible, or collect it on absorbent material, such as dry clay, sand or sawdust. Prevent spilled acetone from entering into water or sewer systems.

Consult with federal, provincial and local governments for advice on disposal. It may be possible to burn small amounts of liquid acetone in an approved solvent burner, or larger quantities in an approved incinerator. It may be possible to dispose of absorbent material containing acetone in an approved landfill site.

XII. REFERENCES

(1) Halton, D.M. How workplace chemicals enter the body. Hamilton, Ont. : CCOHS, 1985

(2) Nelson, K.W.; Ege, J.F.; Ross, M.; Woodman, L.E; Silverman, L. Sensory response to certain industrial solvent vapors. Journal of Industrial Hygiene and Toxicology. Vol. 25, no. 7 (Sept. 1943). p. 282-285

(3) Raleigh, R.L.; McGee, W.A. Effects of short, high-concentration exposures to acetone as determined by observation in the work area. Journal of Occupational Medicine. Vol. 14, no. 8 (Aug. 1972). p. 607-610

(4) Matsushita, T.; Goshima, E.; Miyagaki, H.; Maeda, K.; Takeuchi, Y.; Inoue, T. Experimental studies for determining the MAC value of acetone : 2 : biological reactions in six-day exposure to acetone. Japanese Journal of Industrial Hygiene = Sangyo Igaku. Vol. 11, no. 10 (1969). p. 507-515

(5) Ross, D.S. Acute acetone intoxication involving eight male workers. Annals of Occupational Hygiene. Vol. 16 (1973). p. 73-75

(6) Krasavage, W.J.; O'Donoghue, J.L.; Divincenzo, G.D. Acetone. In: Clayton, G.D.; Clayton, F.E. Patty's industrial hygiene and toxicology. 3rd rev. ed. Toronto : John Wiley & Sons, 1982. Vol. 2C. p. 4720-4727

(7) Henschler, D. Acetone. In: Gesundheitsschaedliche Arbeitstoffe. Weinheim : Verlag Chimie GmbH, 1979. Vol. 1, 7th issue, A. p. 1-4

(8) Grant, W.M. Acetone. In: Toxicology of the eye : vol. 1 : drugs, chemicals, plants, venoms. 2nd ed. Springfield, Ill. : Charles C. Thomas, 1974. p. 83-84

(9) Harris, L.C.; Jackson, R.H. Acute acetone poisoning caused by setting fluid for immobilizing casts. British Medical Journal. Vol. 2 (Nov. 8, 1952). p. 1024-1026

(10) Gitelson, S.; Werezberger, A.; Herman, J.B. Coma and hyperglycemia following drinking of acetone. Diabetes. Vol. 15, no. 11 (Nov. 1966). p. 810-811

(11) Vigliani, E.C.; Zurlo, N. Experiences of Aquanics del Lauor with some maximum concentrations of poisons of industry at the place of work (MAK). Archiv für Gewerbepathologie und Gewerbehygiene (In German). Vol. 13 (1955). p. 528-534

(12) Acetone. Printout from RTECS data base, January 7, 1987

(13) Spector, W.S., ed. Handbook of toxicology. Vol. 1. Philadelphia, Pa. : W.B. Saunders Company, 1956. p. 8

(14) Bello, S.J.; Halton, D.M. What is an LD_{50}? Hamilton, Ont. : CCOHS, 1986

(15) Rengstorff, R.H.; Petrali, J.P.; Sim, V.M. Cataracts induced in guinea pigs by acetone, cyclohexanone, and dimethyl sulfoxide. (Edgewood Arsenal technical report; EATR 4550). Edgewood Arsenal, Md. : Department of the Army, Edgewood Arsenal Research Laboratories, 1971

(16) Hewitt, W.R.; Brown, E.M. Nephrotoxic interactions between ketonic solvents and halogenated aliphatic chemicals. Fundamental and Applied Toxicology. Vol. 4, no. 6 (1984). p. 902-908

(17) Schwope, A.D.; Costas, P.P.; Jackson, J.D.; Weitzman, D.J. Guidelines for the selection of chemical protective clothing. 2nd ed. Cincinnati : American Conference of Governmental Industrial Hygienists, March 1985

(18) NIOSH pocket guide to chemical hazards. Cincinnati : National Institute for Occupational Safety and Health, February 1987

Note: Additional references on this subject are available from CCOHS upon request.

PLEASE NOTE

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This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information which bears on particular work situations may be available. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981; toll free 1-800-263-8276.

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